

Understanding attention deficit hyperactivity disorder as a continuum

John D. McLennan MD MPH PhD FRCPC

Abstract

Objective To review research findings that consider whether attention deficit hyperactivity disorder (ADHD) is a discrete entity or whether it is more consistent with an extreme end-of-trait distribution in the population and to then grapple with the potential clinical implications.

Quality of evidence Peer-reviewed publications in the past 5 years, drawing from diverse fields (taxonomy, epidemiology, genetics, neurobiology, and neuropsychology), were identified through searches in MEDLINE and PsycINFO.

EDITOR'S KEY POINTS

- Although the issue has been debated, attention deficit hyperactivity disorder (ADHD) has generally been conceptualized as a discrete entity with diagnostic thresholds. This review outlines the evidence for variation in attention and activity existing on a continuum, and ADHD representing extreme ends of the continuum.
- As the accumulating evidence suggests that ADHD symptoms occur on a continuum, a shift in how ADHD is conceptualized, diagnosed, and treated is required. Research on the risks and benefits of various interventions at different levels of symptom and functional severity is needed.

POINTS DE REPÈRE DU RÉDACTEUR

- Quoique la question ait fait l'objet de débats, le trouble du déficit de l'attention avec hyperactivité (TDAH) est généralement conceptualisé comme une entité distincte, caractérisée par des seuils diagnostiques. La présente révision met en évidence des données probantes corroborant une variation dans l'attention et l'activité le long d'un continuum, le TDAH représentant l'extrémité distale de ce continuum.
- Étant donné les données probantes qui se multiplient pour donner à croire que les symptômes du TDAH se produisent en continuum, il s'impose de changer la façon de conceptualiser, diagnostiquer et traiter ce trouble. Il faut plus de recherche sur les risques et les avantages de diverses interventions à différents degrés de symptômes et de gravité de la dysfonction.

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Cet article a fait l'objet d'une révision par des pairs
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Main message Accumulating research findings are most consistent with a predominately dimensional rather than a qualitatively distinct existence for ADHD. This does not negate the clinical needs of those who have substantial ADHD symptom clusters, nor the risks that such symptoms entail. However, the lack of discontinuity in the distribution of such traits in the population creates great uncertainty as to what thresholds should prompt explicit intervention.

Conclusion The implications of this pattern of findings might include the need to de-emphasize categorical conceptualizations of ADHD, produce evidence to better inform risk-benefit ratios of interventions along a spectrum of symptom and functional severity, and more coherently triage and arrange service delivery on the basis of symptom and functional severity rather than artificial diagnostic categorizations.

Comprendre le trouble du déficit de l'attention avec hyperactivité comme un continuum

Résumé

Objectif Passer en revue les constatations des études de recherche qui cherchent à savoir si le trouble du déficit de l'attention avec hyperactivité (TDAH) est une entité distincte ou s'il est davantage conforme à une distribution dans la population se retrouvant à l'extrémité distale d'un continuum de traits psychologiques et, le cas échéant, examiner les implications cliniques potentielles.

Qualité des données Des publications révisées par des pairs au cours des 5 dernières années, relevant de diverses spécialités (taxonomie, épidémiologie, génétique, neurobiologie et neuropsychologie), ont été cernées à la suite de recensions dans MEDLINE et PsycINFO.

Message principal De plus en plus d'observations en recherche pointent davantage vers une existence surtout dimensionnelle du TDAH plutôt que distincte sur le plan qualitatif. Ces conclusions ne remettent pas en question les besoins cliniques de ceux qui ont des grappes considérables de symptômes du TDAH, ni les risques que posent de tels symptômes. Par ailleurs, l'absence de discontinuité dans la répartition de tels traits psychologiques dans la population engendre de l'incertitude quant aux seuils qui devraient déclencher une intervention explicite.

Conclusion Les implications de cette tendance observée dans les constatations pourraient inclure la nécessité de moins insister sur les conceptualisations catégoriques du TDAH, de produire des données probantes afin de mieux déterminer les ratios entre les risques et les avantages d'interventions entreprises selon une échelle de gravité sur les plans symptomatiques et fonctionnels, de faire un triage plus cohérent des patients et d'organiser la prestation des services en fonction de cette sévérité, plutôt qu'en se fondant sur des catégories artificielles de diagnostic.

The *Diagnostic and Statistical Manual of Mental Disorders* (DSM) is the resource most frequently cited to describe attention deficit hyperactivity disorder (ADHD). Despite a few modifications with the shift from the fourth (DSM-IV) to the fifth (DSM-5) edition, ADHD retains a categorical structure defined as “inattention and/or hyperactivity-impulsivity” symptom clusters associated with functional impairment.¹ The recent diagnostic stability notwithstanding, the legitimacy of ADHD as a “real” disorder continues to be contested by the general public and, albeit to a lesser degree, the health professional community.² Framing ADHD as a categorical phenomenon when this might not be supported by empirical evidence might be a contributing factor in this contestation.

The aims of this review are to highlight empirical findings from different fields that consider whether the phenomenon of ADHD is more consistent with an underlying continuum of trait distribution in the population or with a discrete categorical entity, and to grapple with the implications of such a continuum for clinical approaches.

Quality of evidence

MEDLINE and PsycINFO databases were searched, from January 1, 2011, to December 31, 2015, using various combinations of the following terms: *ADHD*, *classification*, and *International Classification of Diseases* as MeSH terms, and *continuum*, *dimensions*, and *category* as key words. Identified English-language papers with evidence relevant to whether ADHD is more consistent with a continuum versus a categorical conceptualization were considered. An explicit aim

was to include evidence from different fields, namely taxonomy, epidemiology, genetics, neurobiology, and neuropsychology. Cited references within identified articles were also used as additional sources of information. This article should not be considered a formal systematic review and does not provide a quantitative synthesis of the field.

Main message

That attention and activity variation might fall on continuums and that ADHD might represent extremes on a continuum has been discussed for decades. There does not, however, appear to be clear consensus within the research or clinical community that this should be the dominant organizing framework in our approach to ADHD. Consideration of recent empirical findings might advance the necessary deliberations.

Lack of evidence for a discrete category. Advances in statistics better allow us to determine whether a given phenomenon (eg, ADHD) is discontinuous with trait distribution in the general population versus more consistent with the extreme end of a continuum.² Evidence of the presence of a *taxon*, ie, an “entity with real category boundaries that exist independent of social convention or descriptive convenience,”³ would provide support that a categorical entity exists. Attention deficit hyperactivity disorder does not appear to have a taxon.⁴ The lack of a taxon does *not* mean that a given phenomenon is not linked to suffering or dysfunction or is not worthy of clinical attention. It does call into question, however, categorical classification of this phenomenon.

Genetically informed studies provide an additional source of evidence. Studies conducted with twins to determine heritability estimates for ADHD and ADHD symptoms date back several decades.⁵ Accumulating evidence from increasingly sophisticated twin studies supports the notion that attentional and associated problems are more consistent with a continuum rather than discrete categories.⁶⁻⁸ For example, a large twin study found very similar heritability estimates for ADHD symptoms both at extreme levels and at levels that were below the threshold for diagnosis.⁹ Findings from molecular genetics might provide further support.⁸ For example, a recent study found that polygenic risk scores (based on single nucleotide polymorphisms) associated with ADHD traits in a general population were also related to ADHD in a clinic population.¹⁰

The neurobiology and neuropsychology fields are also yielding support for a dimensional model. An older study contrasting a cohort of ADHD children with a typically developing group found delays in peak cortical thickness attainment in some brain areas and subsequent slower cortical thinning in the ADHD group.¹¹ This same research group recently found that slower cortical thinning was also related to ADHD symptom severity in children who did not meet criteria for ADHD diagnosis.¹² In addition,

a separate research group, studying a large population-based sample of children, found a statistically significant relationship between higher attentional and hyperactivity problems and areas of cortical thinness.¹³ In another study, a research group using neuropsychological tasks assessing dimensions of reaction time that reflect basic information processing found a linear relationship between poorer performance on the task and ADHD symptoms ranging from no symptoms to diagnostic levels of ADHD symptoms, with no evidence of discontinuity.¹⁴

The absence of evidence from the intervention field for a categorical threshold also provides support for a continuum or at least suggests ADHD is not a categorical entity. There is no compelling evidence from medication studies (eg, use of stimulants) that would support a cut point at which a positive effect is noted above, but not below, a given symptom threshold. Certainly larger effects from medications can be measured when starting with more extreme symptoms; however, this is not evidence for a threshold effect, nor does this support the DSM-5 symptom count and severity threshold as meaningful with regard to treatment responsiveness. That there is some evidence of positive effects (eg, attentional improvement) with stimulants in those who do not meet criteria for ADHD—so-called cognitive enhancement—further questions a link between medication responsiveness and a categorical diagnosis.¹⁵

An ADHD threshold is even less meaningful when considering behavioural interventions. There is no evidence that the effect of behavioural interventions are related to ADHD diagnostic thresholds. Behavioural interventions can be effective for problematic behaviour including that encountered as part of typical child rearing. That said, more intensive and structured behavioural approaches are typically needed, as behaviour challenges arise along a continuum.

Implications for assessment and treatment. It has been argued that categorical thinking is justified in medicine given the need to make treatment decisions that are inherently dichotomous (eg, Do I prescribe a drug or not?). That this should then drive the need for categorical diagnoses suggests a case of the “tail wagging the dog” or at least a circular argument providing false comfort in a belief in the precision of the link between diagnosis and treatment. Recognizing the lack of existence of a true categorical diagnosis forces us to consider implications for assessment and treatment at various points along underlying trait distribution.

Three partial ideas might address some, but not all, of the challenges arising from the mounting evidence for a continuum conceptualization of ADHD: move away from categorical classification, develop a research database to inform weighing the risks and benefits of interventions at various symptom severity levels, and improve triage and service delivery based on severity.

First is the need to move away from categorical classifications when the evidence does not support such. Of importance will be investigating how such a change in approach is received by those with identified ADHD and their families. Framing the severe end of a continuum as a categorical phenomenon might have some heuristic value and, it has been argued, aligns better with a human bias toward categorical thinking.³ However, it is misleading if it is not recognized and acknowledged that such categorical presentations are primarily for heuristic or convenience purposes. While it might be more difficult to conceptualize dimensions and continuous distributions, insisting that such phenomena are distinctly and qualitatively different rather than extensions of broader experiences might elicit doubt leading to dismissal and disbelief. That there are substantial complicating financial interests at play might move disbelief to conspiracy.

Unfortunately, movement toward a continuum approach might be impeded by administrative forces demanding categorical application. Our medical billing system, for example, requires the application of categorical diagnoses within the provision of assessment and treatment. Also problematic is the requirement for physician- or psychologist-based categorical diagnoses within some school districts in Canada to facilitate children getting access to certain school accommodations or support services. This approach in schools seems even more contrived given that the school population contains children at every gradation along various continuums.

Unfortunately the DSM-5 did not take a paradigm-shifting approach, such as a more radical reshaping through adoption of a predominately dimensional conceptualization.¹⁶ The inclusion of severity levels within diagnoses might be framed as a move toward a hybrid model but it seems a very modest shift.¹⁷ It is anticipated that the Research Domain Criteria approach proposed by the National Institute of Mental Health might better map onto the cumulating evidence of dimensionality for a range of mental health difficulties.¹⁸

Second is the need for research to develop more refined databases to provide evidence-based information for risk-benefit analysis for interventions at various levels of symptom severity.⁸ Here it might be useful to consider advances in more mature health fields. Hypertension has previously been used as an analogy for ADHD to facilitate understanding of a phenomenon with a clear underlying continuum but with a role for severity threshold points to guide treatment decisions (eg, when to initiate antihypertensive medications).^{6,19} Debate continues on proposed best cut points for hypertension and its treatment.²⁰ In particular, efforts to determine the relative benefits of antihypertensive medications at different blood pressure levels for different ages in differing comorbid contexts²¹ might be instructive.⁸ Such advances might help us move beyond crude overall prevalence indicators of underuse or overuse of medication for ADHD

and simplistic recommendations that medication use should be informed by a questionable categorical threshold.

Third is the potential utility of improved triage, an approach that is realized inconsistently in health care delivery. While its application is very deliberate and systematic in some health care areas (eg, emergency services), it is not in others. Child mental health services, considered broadly, might have one of the most poorly developed triage approaches, in part given the complexity and variability of presentations in combination with an extensively fractionated service delivery system. If a triage system is better implemented such that those with the most concerning mental health symptoms (which can include severity of attention and behavioural difficulties) and functional difficulties systematically receive priority, Canada's public health services would be tapped out by those with severe symptoms or high functional impairment, and there would be little time and few resources left to grapple with the management of more "borderline" difficulties.

This latter point might be particularly relevant for decisions around ADHD medication use; the trade-offs between the risks and benefits should be clearer the further along the continuum of severity. Others have noted parallels in other areas of medicine, such as prioritizing interventions for severe obesity versus mild overweight status.⁸ That said, public health approaches need to strategically consider the full range of milder states given their higher prevalence and consequently their greater potential for population effects.²² The latter calls for more rigorous evaluation of the effectiveness of more population-based approaches (eg, increased physical activity)²³⁻²⁵ that could help children with varying levels of ADHD symptoms.

Recognizing that ADHD is a continuum does not (yet) fundamentally alter important aspects of clinical assessment (eg, use of standardized ratings from parents and teachers) or evidence-based treatment options for the more severe ends of the spectrum. The most robust evidence for reducing symptoms and improving function for children with ADHD presentations continues to be a variety of medications approved for use in ADHD and properly implemented behavioural modification strategies, with some, but less robust, evidence for a set of other interventions (eg, free fatty acid supplementation).^{26,27} The American Academy of Pediatrics has published a particularly well developed practice guideline written for primary care that provides clear recommendations tied to levels of evidence.²⁷ Unfortunately, this guideline does not adequately grapple with the underlying continuum nature of ADHD and defaults to the DSM-defined diagnostic thresholds. Additional efforts are clearly needed.

Conclusion

Primary care and schools are particularly critical contexts in which to try and improve our approach to the continuum of attention and behavioural difficulties in children.

While various specialists also have roles, many might only see the more extreme ends of continuums, in which case they might not be forced to grapple with thresholds related to diagnostic application and intervention provision, whereas primary care and schools are constantly confronting the full range of human behaviour.

Dr McLennan is a child psychiatrist at the Children's Hospital of Eastern Ontario in Ottawa, a scientist at the Children's Hospital of Eastern Ontario Research Institute, Research Chair in Child & Adolescent Psychiatry at the University of Ottawa, and Adjunct Associate Professor at the University of Calgary in Alberta.

Competing interests
None declared

Correspondence
Dr John D. McLennan; e-mail jmclennan@cheo.on.ca

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